CLAIMS

What is claimed is:

1. A microfluidic device, comprising:

a source fluid flow channel;

a target fluid flow channel, the target fluid flow channel being in fluid communication with the source fluid flow channel at a cross-channel area;

a porous membrane separating the source fluid flow channel from the target fluid flow channel in the cross-channel area; and

a field-force/gradient mechanism proximate the porous membrane.

2. The device of claim 1, wherein the field-force/gradient mechanism may include an electric field, a magnetic field, an acoustic wave, ultrasound or light with a specific wavelength.

3. The device of claim 1, further comprising a molecular trapping mechanism for trapping one or more tagged molecules.

4. The device of claim 3, wherein the molecular trapping mechanism includes a nanopore membrane with pores capable of trapping the tagged molecules due to their tags.

5. The device of claim 4, wherein the pores are between 50 angstroms and 10 micrometers.

6. The device of claim 3, wherein the molecular trapping mechanism includes a chemically treated portion of the porous membrane in which the tagged molecules are immobilized in the porous membrane through (bio)chemical immobilization or ligand coupling between the chemically treated portion and the tag.

7. The device of claim 3, wherein the molecular trapping mechanism is part of the field-force/gradient mechanism and includes an electric field generator proximate the porous membrane capable of electrophoretic or dielectrophoretic trapping and control of the tagged molecule.

8. The device of claim 1, further comprising a sensor.

9. The device of claim 8, wherein the porous membrane is the sensor.

10. The device of claim 1, further comprising a light source and a detector, the light source and the detector being focused at the cross-channel area.

11. The device of claim 1, wherein the thickness of the porous membrane is between 0.01 and 50 micrometers.

12. The device of claim 1, wherein the porous membrane is capable of fractionating molecules based on size, molecular weight, charges, chemical affinity or other chemical/physical properties.

13. The device of claim 1, wherein the porous membrane is made of a single crystal porous silicon (PSi).

14. The device of claim 1, wherein the porous membrane is made of a porous polysilicon (PPSi).

15. The device of claim 1, further comprising a substrate, the source fluid flow channel and the target fluid flow channel being formed in the substrate.

16. The device of claim 15, wherein the substrate is made of polydimethyl siloxane (PDMS).

17. The device of claim 15, wherein the substrate is made of silicon.

18. The device of claim 15, wherein the porous membrane is integral with the substrate.

19. The device of claim 1, wherein the device is a disposable device.

20. The device of claim 1, wherein the device is a reusable device.

21. The device of claim 1, wherein the source fluid flow channel and the target fluid flow channel intersect at a 90 degree angle at the cross-channel area.

22. A microfluidic molecular-flow fractionator device, comprising:

a substrate, the substrate including:

one or more source fluid flow channels;

one or more target fluid flow channels in fluid communication with the one or more source fluid flow channels; and

one or more cross-channel areas at the intersection of each source fluid flow channel and each target fluid flow channel;

a porous membrane positioned in each cross-channel area separating the source fluid flow channels from the target fluid flow channels; and

a field-force/gradient mechanism proximate the porous membrane.

23. The device of claim 22, wherein the field-force/gradient mechanism may include an electric field, a magnetic field, an acoustic wave, ultrasound or light with a specific wavelength.

24. The device of claim 22, further comprising a molecular trapping mechanism for trapping one or more tagged molecules.

25. The device of claim 24, wherein the molecular trapping mechanism includes a nanopore membrane with pores capable of trapping the tagged molecules due to their tags.

26. The device of claim 25, wherein the pores are between 50 angstroms and 10 micrometers.

27. The device of claim 24, wherein the molecular trapping mechanism includes a chemically treated portion of the porous membrane in which the tagged molecules are immobilized in the porous membrane through (bio)chemical immobilization or ligand coupling between the chemically treated portion and the tag.

28. The device of claim 24, wherein the molecular trapping mechanism is part of the field-force/gradient mechanism and includes an electric field generator proximate the porous membrane capable of electrophoretic or dielectrophoretic trapping and control of the tagged molecule.

29. The device of claim 22, further comprising a sensor.

30. The device of claim 29, wherein the porous membrane is the sensor.

31. The device of claim 22, further comprising a light source and a detector, the light source and the detector being focused at the cross-channel area.

32. The device of claim 22, wherein the thickness of the one or more porous membranes are between 0.01 and 50 micrometers.

33. The device of claim 22, wherein the one or more porous membranes are capable of fractionating molecules based on size, molecular weight, charges, chemical affinity, or other chemical/physical properties.

34. The device of claim 22, wherein the one or more porous membranes are made of a single crystal porous silicon (PSi).

35. The device of claim 22, wherein the one or more porous membranes are made of a porous polysilicon (PPSi).

36. The device of claim 22, wherein the substrate is made of silicon.

37. The device of claim 22, wherein the substrate is made of polydimethyl siloxane (PDMS).

38. The device of claim 22, wherein the one or more porous membranes are integral with the substrate.

39. The device of claim 22, wherein the device is a disposable device.

40. The device of claim 22, wherein the device is a reusable device.

41. A microfluidic bioreactor device with molecular trapping for trapping tagged molecules, comprising:

a substrate, the substrate including:

one or more source fluid flow channels;

one or more target fluid flow channels in fluid communication with the one or more source fluid flow channels; and

one or more cross-channel areas at the intersection of each source fluid flow channel and each target fluid flow channel;

a porous membrane positioned in each cross-channel area separating the source fluid flow channels from the target fluid flow channels; and

a molecular trapping mechanism for trapping one or more tagged molecules at one or more cross-channel areas.

42. The device of claim 41, wherein the molecular trapping mechanism includes a nanopore membrane with pores capable of trapping the tagged molecules due to their tags.

43. The device of claim 42, wherein the pores are between 50 angstroms and 10 micrometers.

44. The device of claim 41, wherein the molecular trapping mechanism includes a chemically treated semi-permeable porous membrane in which the tagged molecules are immobilized in the porous membrane through (bio)chemical immobilization or ligand coupling.

45. The device of claim 41, wherein the molecular trapping mechanism includes an electric field generator proximate the porous membrane capable of electrophoretic or dielectrophoretic trapping and control of the tagged molecule.

46. The device of claim 41, further comprising a sensor.

47. The device of claim 46, wherein the porous membrane is the sensor.

48. The device of claim 41, further comprising a light source and a detector, the light source and the detector being focused at the cross-channel area.

49. The device of claim 41, further comprising a field-force/gradient mechanism proximate the porous membrane.

50. The device of claim 49, wherein the field-force/gradient mechanism may include an electric field, a magnetic field, an acoustic wave, ultrasound or light with a specific wavelength.

51. A method of fabricating a microfluidic device, comprising:

providing a substrate;

forming a source fluid flow channel on a first side of the substrate;

depositing polysilicon on the substrate and in the source fluid flow channel using low pressure chemical vapor deposition (LPCVD) forming a porous membrane;

forming a target fluid flow channel on a second side, the target fluid flow channel being separated from the source fluid flow channel by the porous membrane; and

positioning a field-force/gradient mechanism proximate the semi-permeable porous membrane

52. The method of claim 51, wherein forming the source fluid flow channel on the substrate includes etching a trench in the substrate.

53. The method of claim 51, wherein forming the target fluid flow channel on a second side of the substrate includes:

sawing a trench from the second side of the substrate near the semi-permeable porous membrane forming the target fluid flow channel; and

chemically etching the trench so that the target fluid flow channel contacts the semi-permeable porous membrane.

54. The method of claim 51, further comprising focusing a light source and a detector at the semi-permeable porous membrane.